human hands together having 10 fingers, and so does the Semitic stock, from the north Mesopotamian writing of which, through the Karosthi and Brahmi alphabets of ancient India, the writing of all the stocks of modern India (barring, of course, Arabic and Latin alphabet writing) is descended.

The Encyclopedia Britannica, 14th edition, quotes F. Cajori in his history of mathematics as stating that zero, and the accompanying principle of position in the writing of figures, were what gave superiority to the Indic system. One finds in literature on the history of mathematics a widespread exultation over the invention of zero.

A study merely of the modern Tamil Dravidian writing of figures is enough to convince one that zero was never invented at all, but was the figure for 10. Twenty is in Tamil naturally enough written as 2-10, 30 as 3-10, etc. But 10 is never written as 1-10, since the 1 would here be considered as superfluous. When the writing of 10 became *conformed* by dint of simple analogy to resemble that of 20 and other zero-terminal decade numbers, by placing the symbol for 1 before the symbol for 10, the so-called invention of zero was attained. It was not an invention but a conformity, an accident.

RÉSUMÉ

V on the clock dial is discovered to be an inverted Greek letter pi, zero the result of a conformatory squeezing.

THE UNIT NUMERALS

Tamil (Dravidian Stock)	Mundari (Kolarian Stock)	Sanskrit (Aryan Stock)	Burushaski (Burushaskian Stock)
on^{y}d^{y}u, 1	mid', 1	éeka, 1	hik, 1
iraṇḍu, 2	baria, 2	dvá, 2	aalto, 2
muun^{y}d^{y}u, 3	apia, 3	trí, 3	iiski, 3
naan^{y}gu, 4	upunia, 4	catúr, 4	waalti, 4
aindu, 5	moṇṛĕa, 5	pán^{y}ca, 5	tsindi, 5
aar^{y}u, 6	turŭia, 6	ṣáṣ, 6	mishiindi, 6
eju, 7	eea, 7	saptá, 7	tale, 7
eṭṭu, 8	írilia, 8	aṣṭáa, 8	aaltambi, 8
onybadu, 9	aarĕa, 9	náva, 9	hunti, 9

THE NUMERALS 10, 11, 20, AND 21

Tamil (Dravidian Stock)	Mundari (Kolarian Stock)	Sanskrit (Aryan Stock)	Burushaski (Burushaskian Stock)
pattu, 10	gelea, 10	dáśa, 10	toorimi, 10
padin^{y}-on^{y}d^{y}u, 11	gel miad', 11	éekaa-daśa, 11	turma hik, 11
iru-badu, 20	hisi, also mid' hisi, 20	viṃśatí, 20	aaltər, 20
irubatt-on^{y}d^{y}u, 21	mid' hisi miad', 21	éeka-viṃśatí,21	aaltər hik, 21

BOTANY.—*Genera of the plant viruses.*[1] H. H. MCKINNEY,[2] Bureau of Plant Industry, Soils, and Agricultural Engineering. (Communicated by JOHN A. STEVENSON.)

The number of virus entities known to infect plants is well over 200. In comparison with the thousands of bacteria and fungi, this number is very small, and some workers have accordingly taken the view that there is no pressing need for a formal nomenclature and classification of the viruses at this time. Some take the view that classification should await the results of the chemists, whereas others think unnecessary confusion will prevail, even with so small a number as 200 entities, if such a policy is pursued. It is reasoned that a system can be evolved that will meet the requirements of the patholo-

[1] Received January 18, 1944.
[2] The author wishes to acknowledge the helpful advice given by John A. Stevenson, Sidney F. Blake, Charles Drechsler, and others and the assistance given by Charles Drechsler and Edith K. Cash in the choice and orthography of technical names.

gists even after the chemists may have devised a satisfactory system.

A full account of the events leading up to James Johnson's system for designating the plant viruses would require a discussion of many contributions in greater detail than seems necessary in the present paper. Investigators had been gathering evidence indicating that plants are attacked by many different viruses, but the most important stimulus probably came from the investigations of the so-called degeneration diseases of the potato, conducted by Schultz and Folsom in the United States and by Quanjer and others abroad. Schultz and Folsom's paper (1923) was greeted with much skepticism, but when subsequent studies failed to alter their conclusion that many distinct viruses may attack a given plant species it became evident that more than cursory attention should be given to the problem of virus nomenclature and classification.

James Johnson (1927) was the first to emphasize that definite steps should be taken to keep the plant viruses in order. In his scheme the major groups were erected on the basis of the hosts in which the viruses were discovered, and within each of these groups designation was by number.

Quanjer (1931) gave a critical but constructive analysis of some of the problems involved in classification, and although he concluded "that our present knowledge is insufficient for classification of plant viruses," he did divide the viruses of the potato into six categories based on the reactions they induce in selected varieties of potato. These reactions included mosaic and five types of necrosis.

Johnson and Hoggan (1935) proposed a classification based on the means of virus transmission and on the simple properties of the viruses. Later Johnson prepared his extensive lists of virus numbers in mimeographed form. One of these lists (*Illustrations of proposed system of nomenclature of plant viruses*) was prepared by Johnson (1935) as chairman of the International Committee on Descriptions and Nomenclature of Plant Viruses, for use by that committee in its deliberations at the Sixth International Botanical Congress in Amsterdam, 1935. This congress adopted Johnson's proposal in principle, and the International Committee was empowered to continue its considerations and establish an acceptable system of virus nomenclature.

Following this, Kenneth M. Smith in 1937 virtually adopted Johnson's proposal with the exception that he used the Latin generic names rather than the common names of the host plants, and he altered some of Johnson's numerical designations. In both proposals preference was given to the host in which the virus was first discovered, the several viruses assigned to a given host were differentiated by Arabic numerals, and strains were designated by letters of the alphabet. Smith made no attempt to classify within the host groups, but he did compile much valuable information on a large number of viruses and insect vectors.

With these concrete proposals came a general interest in the problem. The slight differences in the approaches by Johnson and by Smith raised several important questions in the minds of virologists, and at the meetings held in Indianapolis (December, 1937), the Council of the American Phytopathological Society appointed a committee to arrange for a discussion of the classification and nomenclature of the plant viruses at the Richmond meeting of the Society in December, 1938. At this meeting these problems were discussed from many angles, and the Society expressed its appreciation to the International Committee on Plant Viruses for the work it had done and recommended that said committee continue its efforts to establish an acceptable system of virus nomenclature (Phytopath. 29:388). The discussions at Richmond made it clear that opinion was divided with regard to the procedure to be followed in the naming and classifying of the viruses. It was clear that several investigators wished to explore the possibilities of technical names and of making more use of plant reactions in virus classification. It was evident also that most investigators wished to publish without restraint.

A system advanced by Holmes (1939) is particularly noteworthy in that it represents the first comprehensive attempt to make use of induced plant reactions and other virus characteristics in the framing of Latin binomials and trinomials. Holmes erected a kingdom, one division, two classes, and 11 monogeneric families. One of these families in Class I embraces the bacteriophages, whereas the 10 families in Class II embrace the viruses infecting seed plants. No orders are provided in the scheme, and none of the genera is described. Most of the species are described, but some are set up on the basis of varietal descriptions. Five of these varietal descriptions serve as types for genera.

At the meetings of the Society held in Columbus (December, 1939), the council's recommendation, "that the temporary committee on virus nomenclature be made a standing committee," was confirmed and a committee was appointed. Later, however, this committee was designated as a special committee. During 1940 the efforts of the committee were directed largely towards the orientation of the views of its members. Owing to the international situation it became apparent that there would be delay and uncertainty with respect to the efforts of the International Virus Committee, and several American workers published proposals.

Valleau (1940) classified a limited number of viruses infecting *Nicotiana tabacum* L. He set up a genus *Musivum* based on Holmes's *Marmor tabaci* var. *vulgare* as the type species, and he designated this type *Musivum tabaci*. In addition, he set up three other genera to avoid some of the heterogeneity that is evident in Holmes's genus *Marmor* and redefined the genus *Annulus*. However, he did not assign his genera to families, nor did he take a position with respect to the higher groups proposed by Holmes (1939). Valleau took the view that trinomials should not be applied to mutant strains, that there should be a "catch all" genus for viruses about which little is known, and that most of the viruses in the genus *Marmor* should be placed in it. He suggested that *Marmor* might be retained as the "catch all" genus.

Soon after Valleau's paper appeared, Fawcett (1940) proposed an ingenious plan. In his own words, "It is virtually a simplified Smith's system without the confusion of numbers and Holmes' system without the generic difficulties." Fawcett took the position that "we are not ready for genera in the ordinary concept." He proposed that the stem "vir" be added to the Latin genitive of the generic term of the host in which the virus was first discovered and recognized, dropping any final consonants that occur in this genitive. These names serve as virus genera and are identified as such by the suffix. Fawcett took the position that "these derived 'genera pro tem' should not be considered in the ordinary taxonomic sense." The specific and varietal Latin epithets are formed in accord with the established rules of botanical procedure. By this system the peach-rosette virus becomes *Prunivir rosettae* (Holmes) Fawcett.

Thornberry (1941) proposed that all viruses, bacteriophages, and the Rickettsia be placed in one order (Biovirales) in adjunct to the bacteria (class Schizomycetes, phylum Thallophyta of the Plant Kingdom). He proposed that all viruses infecting the seed plants be assigned to a single genus *Phytovirus* in a family Phytoviraceae. Other families and genera were proposed for the viruses infecting zoological species, for the Rickettsia and for the bacteriophages. Specific epithets in Latin would be formed in accordance with the established botanical procedure.

Although the Special Committee on Nomenclature and Classification of Plant Viruses was not given a specific assignment by the Society, it did proceed to study the problem with the idea of making certain recommendations. From the beginning the members seemed to be in full accord on the desirability of a formal system, and after studying the several proposals already on record a majority of the committee came to favor a Latin system of nomenclature (Bennett, et al., 1943). It was believed that a numerical system would lead to considerable difficulty on account of the chances for duplicating numbers, because slight typographical errors are more troublesome in numbers than in names, and numbers would be more difficult to manage than names when it becomes necessary to clear up the many problems of synonymy that always arise in any field.

It was fully recognized that naming and grouping by hosts is a simple and almost fool-proof procedure and that Fawcett's (1940) proposal represents a very satisfactory and commendable way of applying Latin binomials and grouping viruses by host affinities. However, after a free discussion of the difficulties inherent in other methods of naming and grouping, a majority of the committee took the view that an understanding of virus relationships may evolve more freely if such characteristics as host reactions and modes of transmission serve as the criteria for the genera.

As the committee proceeded in its efforts to draft a proposal, it became evident that there are many details on which it is difficult to obtain agreement at this stage and that many of these details can be decided only after individual workers have had an opportunity to record their views.

GENERAL PROCEDURE

In virus classification the species, genera, families, and higher categories may not be regarded in exactly the same way as they are in the classification of higher plants and animals, but there seems to be no apparent reason why they can not serve the same purpose. The lower categories (species, genus, and family) were conceived by the early philosophers, and they have been and still are used in many departments of knowledge for classifying not only objects but also ideas and languages in various informal ways. The genus has long been regarded as a class more extensive than the species, and the family more extensive than the genus. It seems very clear that these terms denote relative levels in classification and that they may be employed in any branch of knowledge. Linnaeus and others (see Maton, 1805) made use of part or all of these categories in the classifications of minerals and also the human ailments. The Latin binomial system was also applied in these fields. Even today we have such terms as herpes zoster, herpes circinatus, herpes labiales, and molluscum contagiosum to denote certain viruses in man. With the discovery of bacteria, fungi, and Protozoa as etiological agents in disease, it is natural that classification should shift to these agents. However, there can be little doubt that Linnaeus's approach to the problem of disease nomenclature and classification could have served adequately had these etiological agents not been discovered.

In classifying the bacteria it has not been practicable to make use of morphological characteristics throughout; in fact many genera and species are determined by the reactions they induce on suitable substrates. In the fungi the differentiation of strains frequently depends on reactions induced in nutrient media or in suitable host plants, and some genera and many species have been erected on the grounds of preference for some host organ or for some host species.

Bawden (1939) and others have emphasized the high degree of variability of the induced host reactions, and they have taken the view that these reactions are of little value for purposes of virus classification. This high degree of variability is a real problem, but this fact does not necessarily mean that nothing can be done toward reducing variability to a point where host reactions can serve as adequate criteria. The use of host reactions and/or modes of transmission as criteria for virus genera or other categories seems to be a very natural step, because host reactions have long served for the common names, and something is known about means of transmission in all plant viruses. Other virus characteristics have value also, but it appears that such criteria as host range, thermal-death-point, longevity in dry tissue and *in vitro*, reactions to ordinary chemicals, serological reactions, and interference or antagonism between viruses may be of greatest value in the differentiation of species and, in some cases, strains. With the advance of knowledge concerning the histological, cytological, and physiological host reactions induced by viruses, these criteria should assume roles of increasing importance.

Johnson and Hoggan (1935) stressed the classification value of the several modes of transmission and the insect vectors, and they gave these criteria first consideration in their scheme. It is probably too early to generalize on the true value of these criteria, but it does appear that they should be given a thorough trial because certain correlations are suggested. Transmission by inoculation with expressed juice and/or by aphids is rather general among the viruses inducing mosaics, ringspots, and/or necrosis of parenchyma in annual hosts. Whereas, among the woody perennials, similar viruses can be transmitted experimentally for the most part, only through tissue unions or prolonged contact of tissues. It appears that transmission by the hoppers (leafhoppers and planthoppers) obtains in viruses that for the most part are not transmitted by other families of insects (Storey, 1939). Several compilers have indicated that certain viruses are transmitted by both hoppers and aphids, but all claims that have been noted have been checked by the present author in the original papers, and in each instance the claim lacks positive support.

In the scheme here proposed the ten families of Holmes are consolidated into two, Marmoraceae and Rugaceae. All mosaic-inducing viruses and most of those inducing necrosis in parenchyma tissue fall in the Marmoraceae and all viruses characterized by their marked tendency to induce *malformations* but not *mosaic mottling*, all those inducing the *yellows type* of *chlorosis*, and nearly all those known to induce *phloem necrosis* fall in the Rugaceae. The genus *Ruga* is taken as the type for the second family in preference to the genus *Chlorogenus*, because induced malformations seem to be commoner than chlorosis among the viruses that do not fall in Marmoraceae. The two families here proposed essentially provide the two major groups proposed by Bennett (1939).

With very few exceptions the viruses transmitted by expressed juice fall in the Marmoraceae, and with the exception of certain grass-infecting viruses that induce mosaic and/or chlorotic streaking, the hopper-transmitted viruses fall in the Rugaceae. Not all viruses transmitted by white flies are placed in the Rugaceae. The chlorotic reactions induced by the cassava-mosaic virus are typical mosaics according to the writer's observations in West Africa (McKinney, 1929). Furthermore, several mosaic-inducing viruses not transmitted by white flies also tend to induce leaf malformations. At this stage, it seems advisable to place all viruses that induce mosaic mottling in the Marmoraceae.

In the Marmoraceae the means of virus transmission serve as the generic criteria, whereas in the Rugaceae certain host reactions and also the means of transmission serve to differentiate the genera. This procedure is followed at the generic level because it appears that the use of such criteria as thermal-death-point, interference, resistance to aging, and serological reactions would cause difficulties at the species and strain levels. Eighteen genera are described from the information in Holmes's descriptions of the species and the varieties and from information gathered from other sources. Owing to the large volume of literature, however, many original papers are not cited, but reference is made to papers and compilations having extensive literature lists.

Insect vectors with chewing mouth parts are disregarded in the scheme of classification. Vectors with sucking, lapping, or rasping mouth parts, with a few exceptions noted later, are segregated on the basis of insect families. This method of segregation does increase the number of virus genera, but it appears to be one of the surest ways to obtain an objective evaluation of the criteria.

In the genus *Fractilinea* transmission by the two families of hoppers (leafhoppers and planthoppers) is combined, and in the genus *Savoia* transmission by the two families of true bugs is combined. This is done for convenience. When it is considered that members of very closely related insect families are subject to taxonomic rearrangement, it is impracticable at this stage to place a true value on some of these families as criteria for erecting separate virus genera.

It is suspected, however, that some of these insect families may serve as criteria for new virus genera later. On the other hand, it is quite possible that some of the genera may be combined later—*Ruga* and *Savoia*, for example—as certain aphids and true bugs are known definitely to transmit the virus of potato spindle-tuber and also the virus of potato unmottled curly-dwarf in the genus *Acrogenus*.

Transmission by inoculation with expressed juice is rare among the viruses transmitted by hoppers. With the curly-top virus of beet and the yellow-dwarf virus of potato, juice transmission is difficult and dependent on special hosts. In the classification of these viruses emphasis is placed on the vectors.

Viruses within a given host-reaction group that are transmitted by aphids and/or by expressed juice are placed together, and those viruses with which known transmission is limited to tissue union (grafting, budding, dodder unions) or to prolonged contact of tissues without union, are segregated in each host-reaction group in which they occur. Viruses that have been transmitted only by tissue union or by prolonged contact of tissues may be transferred to appropriate genera, or new genera may be established as the vectors are discovered or as transmission by expressed juice is effected. The 6 genera erected for these viruses fulfill the purposes of a single temporary group that was suggested by Valleau (1940). Since it is likely that a large number of viruses would be assigned to a single such group, it seems more practicable to arrange for their classification in the several host-reaction categories, as is done in the proposed scheme, because it is entirely possible that transmission by inoculation with expressed juice may not be effected. Furthermore, the vectors may not be discovered for some of these viruses for many years.

The superstructure of the scheme seems to be of relatively little importance at this time. However, the higher categories are arranged to permit the inclusion of the bacteriophages and the viruses infecting zoological species, as was planned in the scheme devised by Holmes (1939). In Holmes's scheme there are no orders, and Vira is given the rank of kingdom. Thornberry (1941) proposed that an order Biovirales be set up in the class Schizomycetes to embrace the viruses and the bacteriophages. It appears that there is some justification for assigning the viruses to the Plant Kingdom, but it seems unnecessary and unwise to contemplate redefining the Thallophytes, Fungi, and Schizomycetes to accommodate the proposed order Biovirales. In the present scheme the viruses are regarded as exceedingly low forms of life. The study of virus mutants (Holmes, 1936; McKinney, 1937 and 1941) indicates that fixed strains behave essentially as simple genic systems, and, although mutation has not been demonstrated in all viruses, it appears clear that the phenomenon occurs in several that are known to be high-molecular-weight nucleoproteins (Jensen, 1933; McKinney, 1935; Price, 1934). Furthermore, the slight differences *inter se* manifested by some of the wheat-mosaic viruses (McKinney, 1937a), the sugarcane viruses (Summers, 1934), the curly-top viruses (Giddings, 1938), and by several other viruses strongly suggest common ancestries within certain limited groups.

Since the lowest forms of life are usually included with the plants, it is proposed that the viruses be accorded the rank of *division* in the Plant Kingdom, and that this division be designated Viriphyta. It is further proposed that the procedure in virus nomenclature be governed by the International Rules of Botanical Nomenclature (Briquet, 1935) in so far as seems practicable. Subfamilial and tribal designations are purposely omitted in the present scheme.

Although certain viruses manifest natural affinities, it is believed that the plant viruses, like the fungi and other lower forms, do not represent a natural group throughout. Because of the very small number of characters available at any given group level, some of the generic descriptions are very similar with respect to the host reactions. This weakness should gradually disappear with the advance of knowledge concerning the direct characters of the viruses and the induced host reactions. Of the latter, it appears that the cytological and microchemical reactions should become of increasing objective importance as the studies of Bennett (1940), Esau (1935), Hutchins (1933), Kassinis and Sheffield (1941), McWhorter (1941), Rawlins and Thomas (1941), Simonds and Bodine (1943), and many others are extended to additional viruses and hosts. Because of the nature of viruses, the accumulation of many coordinating and contrasting criteria at the generic level will require time.

DEFINITIONS

The term *virus* is used just as the terms *bacterium, fungus,* or *organism* are used to indicate infectious entities.

The term *strain* refers to any virus of intraspecific rank, regardless of its rank in the species.

A *species* is regarded as a group of strains, actually or potentially.

DETAILED METHODS OF PROCEDURE AND SUGGESTIONS

The International Rules of Botanical Nomenclature (Briquet, 1935) serve as the basis of procedure in the present paper, except that descriptions are not in Latin and Articles 41, 42, and 44 are not rigidly applied.

Descriptions of varieties without descriptions of the species or of the genera (Holmes, 1939 and 1941) are without precedent and create difficulties. Also, a system comprised of families, all of which are monogeneric, is without precedent. Technically all these genera and all the binomials that are based only on varietal descriptions may be regarded as *nomina nuda*. However, it appears that the best interests of virus nomenclature will not be served by a rigid application of Articles 41, 42, and 44 at this time.

Eight of Holmes's (1939 and 1941) generic names are retained and supported by descriptions based on information obtained from original sources and from Holmes's handbooks. Four of these genera, *Marmor*, *Lethum*, *Chlorogenus*, and *Acrogenus*, were founded on viruses that Holmes designated by trinomials. Although Holmes used the varietal epithets *vulgaris* and *typicus*, the procedure he followed in setting up his descriptions is not in conformity with the concept of *typicus* in relation to the specific descriptions (Ley, 1943; Croizat, 1943), and it is concluded that these four genera were founded on varieties and not on species. The writer's descriptions of these four genera are for the present regarded as emendations, and authorities are so indicated.

Valleau's (1940) description of *Musivum tabaci* is regarded as the first valid publication of the specific epithet *tabaci*, which as *Marmor tabaci* becomes a new combination and the type species of the genus *Marmor* in the present proposal. The descriptions of the type species *Lethum australiense*, *Fractilinea maidis*, *Chlorogenus callistephi*, and *Acrogenus solani* in this proposal are regarded as first valid publications. In these four species, authority for the specific epithet and authority for the description of the epithet is divided, as provided in Article 48 of the International Rules, i.e., name of the author who supplied the description being appended to the citation with the connecting word *ex*.

The following suggestions are offered:

1. The type-species concept can be applied only in a limited way to the plant viruses. As there are but few of these causal agents that can be maintained indefinitely without great expense, the burden rests on suitable descriptions and photographic records. In this proposal, no genus has been retyped. Even though some of the type species are little known, it appears that the best interests of virus nomenclature will be served if these nomenclatural types are preserved in accordance with Article 18.

2. The technical descriptions for purposes of classification should be confined to those characteristics that seem essential to proper classification. Other sources should be relied upon for the complete information on most of the viruses.

3. In the binomial system, the specific and the generic descriptions are more important than the descriptions of any of the higher categories, and even though a genus may be monotypic its characterizing features can and should be clearly set forth apart from the descriptions of the species, and the family. Each species should be designated as a binomial and be described.

4. In those genera in which transmission by tissue union is the criterion, the species should be transferred to other genera as transmission by expressed juice is effected or as insect vectors are discovered. To avoid needless changes in nomenclature it is suggested that these generic names be retained even if the type species are transferred.

5. A given virus may induce a wide range of reactions in its several suscepts, therefore, it is necessary to select the host or hosts that best characterize it.

6. The host reactions employed in the scheme are induced by viruses that are established in nature, and which may be regarded essentially as wild types. The scheme is adequate for many mutants isolated in the laboratory, but with some of these that induce indefinite reactions, the generic allocations will be determined on the basis of other suitable criteria that indicate relationship to a wild type.

7. Since so many viruses induce general dwarfing of the plant, this characteristic should be emphasized in classification only when the virus induces few other diagnostic reactions.

8. The phenomenon of compatibility and incompatibility (interference, antagonism, cross protection) between viruses may be expressed in varying degrees, depending on the viruses that are being tested, on the host, and on the environment (McKinney, 1941a). It seems unwise to assume that the phenomenon should serve as a single means for "proving" or "disproving" natural relationship between little-known viruses, but like any other character, when properly used, it may serve as a criterion for differentiating virus groups. Throughout botany and zoology there is ample evidence that the concept of relationship evolves from a knowledge of many characters at each of the levels in a particular scheme.

GENERA OF THE PLANT VIRUSES

Kingdom PHYTA

Division VIRIPHYTA

Syn.: Kingdom Vira Holmes (1939).

Causal agents of infectious diseases, ultramicroscopic in size, propagating only in association with living cells; in some cases capable of mutation and originating fixed strains that behave as simple genic systems and exceedingly low forms of life.

Class Phytophagi

Syn.: Division Phytophagi Holmes (1939).

Viruses pathogenic in plants.

Order SPERMATOPHYTOPHAGALES

Syn.: Class Spermatophytophagi Holmes (1939).

Viruses pathogenic in the seed plants.

Family 1. Marmoraceae Holmes emend.

Annulaceae Holmes (1939); Lethaceae Holmes (1939); Rugaceae Holmes (1939) p.p.; Nanaceae Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing mosaic mottling, veinbanding, discrete chlorotic spotting or streaking in the foliage; local necrotic spotting and/or systemic necrosis. Bud proliferation and malformations of the foliage are attendant reactions in some instances, but these reactions do not typify the family. All mosaic-inducing viruses fall into this family. Transmission of many species by expressed juice and/or by aphids, a few species by leafhoppers, planthoppers, or other insects, and many species by tissue union. Type genus, *Marmor* Holmes (1939) emend.

KEY TO THE GENERA

A. Transmission by expressed juice.
- *1.* Insect vectors aphids or unknown.............................. Genus 1. *Marmor*
- *2.* Insect vectors thrips...... Genus 2. *Lethum*

B. Transmission limited to insect vectors and/or to tissue union.[3]
- *1.* Transmission by aphids... Genus 3. *Poecile*
- *2.* Transmission by leafhoppers or planthoppers .... Genus 4. *Fractilinea*
- *3.* Transmission by white flies.................................. Genus 5. *Ochrosticta*
- *4.* Transmission by tissue union, insect vectors unknown.......... Genus 6. *Flavimacula*

[3] Throughout the keys, *transmission by tissue union* includes grafting, budding and dodder unions, and prolonged contact of cut tissues without organic union.

Genus 1. **Marmor** Holmes emend.

Marmor Holmes (1939), p.p.; *Annulus* Holmes (1939); *Musivum* Valleau (1940); *Murialba* Valleau (1940); *Foliopellis* Valleau (1940); *Tractus* Valleau (1940).

Viruses inducing disturbances of the plastid pigments and/or necrosis, especially in the parenchyma tissues, causing chlorotic mosaic mottling or spotting, oak-leaf patterns, ring spotting, local necrotic lesions, and sometimes systemic necrosis; malformations and/or bud proliferations sometimes accompanying the chlorotic reactions; sometimes disturbances in the glucoside pigments, especially in certain graminaceous hosts, causing purple and red colorations. Transmission by expressed juice in all members; insect vectors aphids (Aphididae) or unknown. Type species, *Marmor tabaci.*

Marmor embraces most of the species inducing the typical mosaics and the ringspots, nearly all the species that can be studied outside the plant, and all species known to be nucleoproteins. Most of the suscepts are herbaceous annuals.

Marmor tabaci (Holmes ex Valleau), comb. nov.

Tobacco virus 1 Johnson (1927); Nicotiana virus 1 Smith (1937); *Marmor tabaci* var. *vulgare* Holmes (1939); *Musivum tabaci* (Holmes ex Valleau) Valleau (1940).

Common name.—Tobacco-mosaic virus.

Host reactions.—In *Nicotiana tabacum* L. var. Samsun (Turkish) and most other commercial varieties of tobacco, *N. sylvestris* Spegaz. and Comes, *Lycopersicon esculentum* Mill. var. Bonny Best, and other commercial varieties of tomato, virus increase is very great and induces conspicuous light-green mosaic mottling at all the usual culture temperatures; in the tobaccos the reactions manifest acute and chronic types (McKinney and Clayton, 1943), especially under field culture when acute burning occurs in var. Maryland Medium Broadleaf and certain other varieties; virus content of leaves with acute chlorosis higher than in leaves with chronic mosaic. In *N. glutinosa* L. and *N. rustica* L., induces local necrotic lesions, systemic necrosis or mosaic mottling when cultured at 24°, 31°, or 37° C., respectively. In *Plantago major* L. secondary symptoms are feeble or null. In certain collections of *N. tabacum* from Colombia (derivatives from Ambalema tobacco and T.I. 448 tobacco, McKinney, 1943), and in *N. glauca* R. Grah., virus increase is very low, inducing only occasional chlorotic spots or no visible reactions. *Cucumis sativus* L. is immune. This species has a very wide host range.

Transmission.—Readily by inoculation with expressed juice in the suscepts listed, by the following aphids (Aphididae): *Macrosiphum gei* Koch, *Myzus pseudosolani* Theob., and *M. circumflexus* (Buckt.), after feeding on infected *Lycopersicon esculentum;* by tissue union (grafting and dodder).

Mutation.—All field collections of the species (wild types) are very similar but not identical in all hosts; all collections that have been studied have given rise to aberrant types. Interference or antagonism (protection) has occurred in all tests thus far in which wild types were in combination with their known mutants, and the wild types have always dominated and supplanted the mutants in the new tissues. Combinations of these mutants, also combinations of *Marmor tabaci* and certain other virus species, have shown that interference is definitely a quantitative phenomenon that is influenced by the viruses in combination, by the host and by the external environment (McKinney, 1941a).

Physical and chemical properties.—The type virus and the strongly invasive strains tested thus far are inactivated at 88° to 93° C. in 10 minutes in plant juices; activity not lost completely after storage for many years in dry tissue or plant extract at room temperature; dilution end-point in fresh plant extract from mosaic tobacco 1,000,000 × or beyond; ultimate particle (micelle or molecule) rod shaped with a minimal diameter of particles about 11.5mμ; paracrystals at p_H 4.5, length 3.2 to 4.2μ, width 0.4 to 0.5μ; high molecular-weight nucleoproteins; possessing antigenetic properties that distinguish it from other virus species, and that serve to distinguish between some but not all its strains.

Distribution.—World wide with tobacco culture.

Type virus.—James Johnson, University of Wisconsin, Madison, Wis.; Rockefeller Institute for Medical Research, Department of Animal and Plant Pathology, Princeton, N. J.;

H. H. McKinney, U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering, Beltsville, Md.

Genus 2. **Lethum** Holmes emend.

Viruses inducing disturbances causing bronzing, chlorotic and necrotic spotting, and ringspotting in foliage; in some hosts typical mosaic mottling; severe necrosis and death in certain hosts; distortion and curling of leaves sometimes as attendant reactions. Transmission by expressed juice; all species transmitted by thrips (Thripidae). Type species, *Lethum australiense.*

Lethum australiense Holmes[4]

Tomato virus 1 Johnson (1935); Lycopersicon virus 3 Smith (1937); *Lethum australiense* var. *typicum* Holmes (1939).

Common name.—Tomato spotted-wilt virus.

Host reactions.—In *Lycopersicon esculentum* Mill. var. Bonny Best and other commercial varieties of tomato, induces a bronze coloration necrosis, and sometimes mottling; bronzing involving entire surface of leaflet or occurring as rings, which become necrotic; necrosis first involving the upper epidermal cells, then the spongy parenchyma; systemic necrosis sometimes killing plants when infected as seedlings; pale red, yellow, or white blotching on ripe fruit, sometimes involving most of surface. In *Nicotiana tabacum* L. var Samsun (Turkish), and var. White Burley, induces local necrotic lesions or plaques on the inoculated (wiped) leaves; necrosis sometimes systemic and fatal to the plant or to all leaves except those in the growing tip; sometimes systemic mottling. In *Petunia* sp. (garden varieties) local reddish-brown lesions with pale centers; rarely systemic.

In *Nicotiana glutinosa* L. local necrotic lesions that become larger than those induced by *Marmor tabaci;* systemic necrosis and death of plant in some cases. In *Datura stramonium* L. concentric-ring spotting, necrotic oak-leaf patterns; typical mosaic mottling, especially during summer season. In *Pisum sativum* L. (garden varieties) systemic necrotic streaks in stem and veins of leaflets; sometimes local necrotic spots on wiped leaflets; necrosis involving parenchyma tissue and phloem; sometimes a mottled pattern on leaves infected when young. In *Ananas sativus* L. induces the yellow-spot disease (Hawaii); in *Nicotiana tabacum* the "vira-cabeca" (Brazil); in *N. tabacum* and *Lycopersicon esculentum* the "kromneck" disease (So. Africa); in *N. tabacum* the "corcova" disease (Argentina), and in *L. esculentum* the tip-blight disease (Oregon and W. Virginia)—the causal agents, if not identical with *Lethum australiense*, appear to be strains. Collections of this virus or its strains that have been observed in tobacco by the author, induced reactions that were strikingly similar to those induced by the tobacco ringspot virus. *L. australiense* has a very wide host range.

Transmission.—By inoculation with expressed juice wiped on leaves dusted with fine carborundum dust, grain 600 or equal; by the following thrips (Thripidae): *Thrips tabaci* Lind., *Frankliniella paucispinosa* Moult., *F. moultoni* Hood, *F. lycopersici* Andr., and *F. occidentalis* Perg.

Physical and chemical properties.—Inactivated at temperatures near 42° C. in 10 minutes in plant juices; in a few hours at room temperatures in plant juices or in drying itssue. Dilution end-point between 10,000 and 100,000 ×. Passes Gradocol membrane with pore diameter of 450 mμ.

Distribution.—Australasia, United States, Great Britain, probably Hawaii, South Africa, and South America.

Genus 3. **Poecile**, gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing mosaics, marginal yellowing, of yellow patching in foliage; in some cases bud proliferation and leaf malformations are attendant reactions. Transmission by expressed juice not typical, null or exceedingly difficult; all species transmitted by aphids (Aphididae). Name from Latin meaning variegation (fem.). Type species, *Poecile rubi.*

Poecile rubi (Holmes), comb. nov.

Raspberry virus 2 Johnson (1935); Rubus virus 1 Smith (1937); *Marmor rubi* Holmes (1939).

Common name.—Raspberry-mosaic virus.

Genus 4. **Fractilinea**, gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing disturbances of the plastid

[4] For citation of authority see p. 145, col. 2, par. 1.

pigments causing pale green to yellow or almost white opaque or translucent streaks (continuous or broken), spotting or speckling; bud proliferation (rosetting) and marked general dwarfing in some cases. Transmission by expressed juice not typical, null or exceedingly difficult; all species transmitted by leafhoppers or planthoppers (Cicadellidae or Fulgoridae). Name from two Latin words signifying *interrupted* and *line* (fem.), referring to the broken chlorotic lines and streaks induced in the leaves. Type species, *Marmor maidis*.

Fractilinea maidis (Holmes),[5] comb. nov.

Corn virus 2 Johnson (1935); Zea virus 2 Smith (1937); *Marmor maidis* var. *typicum* Holmes (1939).

Common name.—Maize (corn)-streak virus.

Host reactions.—In *Zea mays* L. and *Saccharum officinarum* L. var. Uba. induces light-green spots, broken and continuous chlorotic streaks. On the latter host the reactions are milder and the virus does not persist in the new foliage.

Transmission.—By the following leafhoppers (Cicadellidae): *Cicadulina* (*Balclutha*) *mbila* (Naudé), *C. storeyi* China, and *C. zeae* China; not by inoculation with expressed juice. *Cicadulina mbila* is heterozygous for the virus-transmission character, and this character is sex linked. No morphological characters have been found that distinguish the race that transmits from the one that cannot transmit virus. Presumably the difference is in the permeability of the intestinal wall.

Mutation.—Not demonstrated. *Marmor maidis* var. *sacchari* Holmes (1939) and *M. maidis* var. *mite* Holmes (1939) are similar to *Fractilinea maidis*, but it is largely a matter of opinion as to their rank. They may represent strains of *F. maidis* or they may be closely related species.

Physical properties.—Virus passes a Chamberland L_3 filter but is retained by the Seitz E. K. filter disk when the p_H is near 6.

Distribution —Africa.

Genus 5. **Ochrosticta**, gen. nov.

Ruga Holmes (1939) p.p.

Viruses inducing mosaic mottling. Leaf deformations and bud proliferations sometimes attendant reactions, but these do not characterize the genus. Transmission by expressed juice null; all species transmitted by white flies (Aleyrodidae). Name from two Greek words meaning *yellow* and *dapple* (fem.), referring to the chlorotic mottling reaction. Type species, *Ochrosticta bemisiae*.

[5] See footnote 4.

Ochrosticta bemisiae (Holmes), comb. nov.

Manihot virus 1 Smith (1937); *Ruga bemisiae* Holmes (1939).

Common name.—Cassava-mosaic virus.

Genus 6. **Flavimacula**, gen. nov.

Marmor Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing disturbances of the plastid pigments causing chlorotic and/or necrotic spotting and sometimes mosaics with attendant rosetting of leaves; a few species inducing disturbances of the glucoside pigments, but no striking bud proliferation; malformations such as leaf curling, etc., sometimes are attendant reactions. Experimental transmission limited to tissue union; insect vectors not known. Name from two Latin words meaning *yellow* and *spot* or *smear* (fem.), referring to the chlorotic spotting or mottling reaction. Type species, *Flavimacula persicae*.

Flavimacula persicae (Holmes), comb. nov.

Peach virus 6 Johnson (1935); Prunus virus 5 Smith (1937); *Marmor persicae* Holmes (1939).

Common name.—Peach-mosaic virus.

Many members of this genus have rosaceous hosts, relatively few typical mosaic patterns are induced and little is known concerning properties other than host reactions and the mode of transmission.

Family 2. RUGACEAE Holmes emend.

Nanaceae Holmes (1939) p.p.; Coriaceae Holmes (1939); Savoiaceae Holmes (1939); Marmoraceae Holmes (1939) p.p.; Chlorogenaceae Holmes (1939); Acrogenaceae Holmes (1939) and Gallaceae Holmes (1939).

Viruses inducing cellular disturbances causing various malformations such as bud proliferation (rosetting or brooming), thickening of tissues, enation, leaf curl, galls, cortical lesions (cankers), vascular proliferation and/or dwarfing. Phloem necrosis induced by some members (necrosis sometimes extending well into the parenchyma). Many members not inducing striking attendant disturbances of the plastid or glucoside pigments; pigment disturbances when evident usually involving entire leaves or diffuse patches causing the yellows type of chlorosis, and not mosaic; some species tending to induce intensification of green coloration. Transmission frequently limited to tissue union and/or to insect vectors; few species transmitted by inoculation with expressed juice. Type genus, *Ruga* Holmes (1939) emend.

KEY TO THE GENERA

A. Viruses inducing bud proliferation causing brooming or rosetting; sometimes dwarfing reactions.
- *1.* Viruses inducing pigment disturbances in foliage
  - *a.* Transmission by leafhoppers.......................... Genus 1. *Chlorogenus*
  - *b.* Transmission by tissue union, insect vectors not known. Genus 2. *Chlorophthora*
- *2.* Induced pigment reactions null, inconspicuous or inconstant.
  - *a.* Transmission by aphids................................ Genus 3. *Blastogenus*
  - *b.* Transmission by tissue union, insect vectors not known.... Genus 4. *Polycladus*

B. Viruses inducing chiefly malformations of foliage as curling, crumpling, rolling, perforation, laceration, enations, galls, dwarfing; maldevelopment and/or malformation of fruit; general dwarfing of plant usually an attendant reaction. Virus-induced proliferation null or inconstant; general chlorosis and/or accentuation of glucoside pigments induced by a few members, but not a characteristic of the group.
- *1.* Transmission by aphids... Genus 5. *Corium*
- *2.* Transmission by true bugs. Genus 6. *Savoia*
- *3.* Transmission by leafhoppers or planthoppers .... Genus 7. *Galla*
- *4.* Transmission by white flies.. Genus 8. *Ruga*
- *5.* Transmission by tissue union, insect vectors not known....... Genus 9. *Carpophthora*

C. Viruses characterized by their reactions in and near cortex of the trunk and branches; reactions in other parts null or of low diagnostic value.
- *1.* Transmission by tissue union, insect vectors not known........ Genus 10. *Rimocortius*

D. Viruses inducing general dwarfing of host or its parts; green coloration of foliage frequently intensified; other reactions null or of low diagnostic value.
- *1.* Transmission by expressed juice, vectors aphids and/or true bugs or not known .... Genus 11. *Acrogenus*
- *2.* Transmission by tissue union, insect vectors not known........... Genus 12. *Minuor*

Genus 1. **Chlorogenus** Holmes emend.

Chlorogenus Holmes (1939) p.p.

Viruses inducing bud proliferation causing brooming or rosetting of shoots or leaves; malformation and dwarfing of leaves; pigment disturbances causing general yellowing or diffuse yellowish patching of foliage; disturbances of glucoside pigments sometimes causing reddening and purpling of foliage. No typical mosaic mottling. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by leafhoppers (Cicadellidae). Type species, *Chlorogenus callistephi.*

Chlorogenus callistephi Holmes[6]

Callistephus virus 1 Smith (1937); *Chlorogenus callistephi* var. *vulgaris* Holmes (1939).

Common name.—Aster-yellows virus.

Host reactions.—In *Callistephus chinensis* Nees. stimulates lateral bud and side-shoot development; shoots slender, wiry and upright, tending to have long internodes; shortening of main-stem internodes; leaves narrow, deformed and upright; induces general chlorosis, especially in young tissues (leaves, petioles, stem, and branches); sectorial chlorosis occurring in some leaves, but never mosaic mottling; floral straps becoming virescent, and their trichomes frequently developing into leaflike structures; mild necrosis usually appearing just below apex of the stem, flowers usually sterile. The stimulation of buds with the development of side shoots is somewhat more constant than the chlorotic reaction among the many susceptible host species.

Transmission.—By the leafhopper (Cicadellidae) *Macrosteles divisus* (Uhl.); by grafting; not by inoculation with expressed juice.

Physical properties.—Inactivated in the insect vector in 12 days at 31° C.

Distribution.—United States; Canada, Bermuda, Hungary, and Japan.

Genus 2. **Chlorophthora,** gen. nov.

Chlorogenus Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing bud proliferation causing brooming of twigs or rosetting of leaves, chlorosis or bronzing, malformation and dwarfing of foliage, malformation and sometimes in-

[6] See footnote 4.

tensification of color in fruit. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words meaning *green* and *destruction* (fem.) referring to the destruction of chlorophyll induced in the foliage. Type species, *Chlorophthora solani.*

Chlorophthora solani (Holmes), comb. nov.

Potato virus 11 Johnson (1935); Solanum virus 15 Smith (1937); *Chlorogenus solani* Holmes (1939).

Common name.—Potato witches'-broom virus.

Genus 3. **Blastogenus,** gen. nov.

Nanus Holmes (1939), p.p.

Viruses inducing bud proliferation causing brooming or rosetting of twigs or leaves without striking chlorosis. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by aphids (Aphididae). Name from two Greek words signifying *bud* and *producing* (masc.), referring to the large number of buds activated. Type species, *Blastogenus fragariae.*

Blastogenus fragariae (Holmes), comb. nov.

Strawberry virus 2 Johnson (1935); Fragaria virus 3 Smith (1937); *Nanus fragariae* Holmes (1939).

Common name.—Strawberry witches-broom virus.

Genus 4. **Polycladus,** gen. nov.

Chlorogenus Holmes (1939) p.p.; *Galla* Holmes (1939) p.p.; *Nanus* Holmes (1939) p.p.

Viruses inducing bud proliferations causing brooming or rosetting of twigs, leaves or floral parts; no striking chlorosis; malformations and/or dwarfing of leaves. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words signifying *many shoots* or *branches* (masc.), referring to the excessive number of shoots induced. Type species, *Polycladus robiniae* Holmes (1939).

Polycladus robiniae (Holmes), comb. nov.

Robinia virus 1 Smith (1937); *Chlorogenus robiniae* Holmes (1939).

Common name.—Locust witches'-broom virus.

Genus 5. **Corium** Holmes (1939)

Corium Holmes (1939); *Nanus* Holmes p.p. (1939).

Viruses inducing foliar malformations as rolling, puckering, wrinkling, dwarfing etc.; some species inducing mild general chlorosis in the leaves; no consistently striking bud proliferation. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by aphids (Aphididae). Type species, *Corium solani.*

Corium solani Holmes (1939)

Potato virus 1 Johnson (1935), Solanum virus 14 Smith (1937).

Common name.—Potato leaf-roll virus.

Genus 6. **Savoia** Holmes (1939)

Viruses inducing foliar malformations as wrinkling, twisting, curling, dwarfing, etc.; phloem necrosis in roots and premature death of host in some cases; chlorosis when evident is diffuse, not typical mosaic. Transmission by expressed juice in some cases, but with difficulty; all species transmitted by true bugs (Tingitidae or Miridae). Type species, *Savoia betae.*

Savoia betae Holmes (1939)

Sugar-beet virus 3 Johnson (1935); Beta virus 3 Smith (1937).

Common name.—Beet leaf-curl virus.

Genus 7. **Galla** Holmes (1939)

Marmor Holmes (1939), p.p.; *Chlorogenus* Holmes (1939), p.p.; *Galla* Holmes (1939), p.p.

Viruses inducing malformations of foliage as curling, rolling, cupping, crumpling, galls; degeneration or necrosis of the phloem sometimes extending well into the parenchyma tissues; chlorosis (not mosaic mottling) and/or bud proliferation in some hosts but chlorosis and proliferation do not characterize the genus. Transmission by expressed juice null or too difficult for purposes of classification; all species transmitted by planthoppers (Fulgoridae) or by leafhoppers (Cicadellidae). Type species *Galla fijiensis.*

Galla fijiensis Holmes (1939)

Sugar-cane virus 2 Johnson (1935); Saccharum virus 2 Smith (1937).

Common name.—Sugarcane Fiji-disease virus.

Genus 8. **Ruga** Holmes (1939)

Ruga Holmes (1939), p.p.

Viruses inducing foliar malformations as rolling, puckering, wrinkling, dwarfing, etc.; thickening of veins; mild chlorosis (not mosaic mottling) in some cases but this reaction is too inconstant for purposes of classification. Transmission by expressed juice null or too difficult for use in classification; all species transmitted by white flies (Aleyrodidae). Type species *Ruga tabaci.*

Ruga tabaci Holmes (1939)

Tobacco virus 16 Johnson (1935); Nicotiana virus 10 Smith (1937).

Common name.—Tobacco leaf-curl virus.

Genus 9. **Carpophthora,** gen. nov.

Marmor Holmes (1939) p.p.

Viruses inducing foliar malformations as twisting, enations, warts, rolling, folding, puckering, tattering, perforation; early drop of leaves and fruit in some hosts; maldevelopment and malformations in fruit in some cases without reactions in foliage; some members inducing yellowing and reddening or purpling of foliage, bark cankers, phloem necrosis, twig die-back and sometimes death of tree; bud proliferation null or not a striking characteristic, and not typifying the genus. Experimental transmission limited to tissue union; insect vectors not known. Name from two Greek words signifying *fruit* and *ruin* or *destruction* (fem.). Type species, *Carpophthora lacerans.*

Carpophthora lacerans (Holmes), comb. nov.

Marmor lacerans Holmes (1939).

Common name.—Peach X or yellow-red-disease virus (Hildebrand et al. 1942).

If this virus, sweet-cherry buckskin-disease virus (Rawlins and Thomas, 1941), and peach-leaf-casting-yellows virus (Thomas, Rawlins, and Parker, 1940) are identical, consideration should be given to the common name "buckskin disease," which antedates the other names. (See the literature lists in Hildebrand et al., 1942.)

Genus 10. **Rimocortius** Milbrath and Zeller (1942)

Viruses inducing reactions chiefly in the cortical region of woody stems and branches causing swelling, scaling, cracking, checking, splitting, cankering, and/or gumming; splitting and crosscracking of the midribs of leaves, causing leaf curling in some instances. Chlorosis absent or not striking, sometimes vein clearing or stippling, but not typical mosaic mottling. Experimental transmission limited to tissue union or possibly to prolonged contact of tissue without organic union; insect vectors not known. Type species, *Rimocortius kwanzani.*

Rimocortius kwanzani Milbrath and Zeller (1942)

Common name.—Flowering-cherry rough-bark virus.

Host reactions.—In *Prunus serrulata* Lindl. var. *Kwanzan*, induces longitudinal and transverse splitting, and deep brown coloration of the bark; shortening of stem internodes and clustering of leaves; downward arching or curling of leaves, with frequent longitudinal and transverse cracking of the underside of the midribs; general dwarfing of the tree and reduced number of lateral branches. No definite chlorotic reactions in foliage. Wild *P. avium* L. (Mazzard) is a symptomless carrier of the virus. Other varieties of *P. serrulata* apparently are immune.

Transmission.—By budding and grafting; organic union need not be sufficient for bud development (possibly a prolonged contact of tissues without organic union is sufficient to effect transmission). No insect vectors have been found.

Distribution.—Oregon.

Genus 11. **Acrogenus** Holmes emend.

Viruses inducing a general dwarfing of plants and/or foliage; chlorosis; rolling and wrinkling of foliage null or slight, intensification of green coloration of foliage a common reaction. Transmission by expressed juice in all species; insect vectors aphids (Aphididae) and/or true bugs or not known. Type species, *Acrogenus solani.*

Acrogenus solani Holmes[7]

Potato virus 8 Johnson (1935); Solanum virus 12 Smith (1937); *Acrogenus solani* var. *vulgaris* Holmes (1939).

Common name.—Potato spindle-tuber virus.

Host reactions.—In *Solanum tuberosum* L., induces delayed emergence; stiff, spindly, erect

[7] See footnote 4.

stems; small, erect, dark-green leaves with slender brittle petioles; twisted terminal leaves; elongated, cylindrical, tapered tubers with irregular contour, smooth tender skin and prominent eyes, flesh of tubers brittle at harvest, but softer than normal after storage.

Transmission.—By inoculation with expressed juice, by aphids (Aphididae), *Myzus persicae* (Sulz.) and *Macrosiphum gei* Koch; tarnished plant bug (Miridae), *Lygus pratensis* L., also by certain chewing insects, grasshoppers (Locustidae), *Melanoplus* spp.; flea beetles (Chrysomelidae), *Epitrix cucumeris* Harris and *Systena taeniata* (Say); leaf beetles (Chrysomelidae), *Disonycha triangularis* (Say), and Colorado potato-beetle larvae (Chrysomelidae) *Leptinotarsa decemlineata* Say.

Geographic distribution.—United States and Canada.

Genus 12. **Minuor** Zeller and Braun (1943)

Nanus Holmes p.p.

Viruses inducing general dwarfing or stunting of the plant as a whole or its parts; some species inducing intensification of green coloration of the foliage. Malformation and chlorosis absent or of little diagnostic value. Experimental transmission limited to tissue union; insect vectors not known. Type species: *Minuor ruborum.*

Minuor ruborum Zeller and Braun (1943)

Common name.—Raspberry decline-disease virus.

Host reactions.—In *Rubus idaeus* L. var. Cuthbert, when infection occurs late in the season, virus retards growth of new shoots and intensifies their reddish color the following spring. In the field the leaves on these canes show no symptoms until growth slows down in the autumn, when they roll downward and become fluted along the veins; leaves toward the cane tips show very slight chlorosis between the veins and a slight bronzing along the margins and crests between the veins; the cane internodes toward the tip are shortened. In greenhouse culture the downward rolling of the leaves is evident throughout the growing season. In the field, infected canes are small and weakened as evidenced by winter killing or failure of lateral buds; the feeder rootlets become reduced and the whole plant deteriorates progressively until death, which occurs at a maximum of about 3 years after infection. The berries are globose and the druplets separate readily, rendering the fruit worthless. Infection spreads from a diseased-plant center causing spotted areas that may be over 200 feet in diameter. Other varieties of *R. idaeus* and other species of *Rubus* have shown reactions resembling those induced by the decline-disease virus in the Cuthbert variety. All attempts to isolate and culture a parasite have failed.

Transmission.—By grafting; insect vectors not known.

Distribution.—Willamette Valley, Oreg.; possibly British Columbia.

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ZOOLOGY.—*Notes on a small collection of reptiles and amphibians from Tabasco, México.*[1] HOBART M. SMITH. (Communicated by HERBERT FRIEDMANN.)

Walter A. Weber, of the U. S. National Museum, naturalist to the Fifth National Geographic Society–Smithsonian Institution Expedition to southern México, under the leadership of Matthew W. Stirling, collected a small series of reptiles and amphibians near the base camp at La Venta, Tabasco. The material, now a part of the collections of the U. S. National Museum, was obtained in March and April, 1943. It was made available to me for study through the courtesy of Dr. Alexander Wetmore. It contains 12 specimens of nine species, five of which have not previously been recorded from the state of Tabasco, while one has not been collected for more than 50 years

[1] Received January 11, 1944.